

## CHAPTER 13

# Storage

### INDUSTRY EARLY REVIEW DRAFT V.0.3 — 07/20/1999 7:38 PM–

**NOTE to REVIEWERS:** This is a very early draft version, and no effort has been made to reconcile changes in cross references to other chapters in the guide. Please look for comments such as this in the draft, which encourage your feedback on specific issues.

**Please submit comments using the form on <http://www.pcdesguide.org> or by sending e-mail to [comments@pcdesguide.org](mailto:comments@pcdesguide.org).**

**IMPORTANT:** The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows98 “Millennium” or later or Windows2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

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## Storage Basic Guidelines

This section presents the requirements for storage and related peripherals, including DVD devices. For related acoustical requirements for storage devices, see requirement [3.7], “Audible noise meets PC 2001 requirements.”

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For specific information about implementation details related to storage devices under the Windows 98 and Windows 2000 operating systems, see the articles at <http://www.microsoft.com/hwdev/storage/>.

### [18.1] Storage components and optical devices support bus master capabilities

**NOTE: Bus master support is required of optical device in this timeframe in order to adequately support video playing for DVD and CD-ROMs.**

Hard disk and optical devices (such as CD and DVD devices) must support bus mastering, and bus mastering must be enabled on the host by default. When correctly implemented, bus master support ensures improved performance and Windows-compatible device driver support.

Bus master capabilities must meet the related specification for the particular controller. For example, the programming register set for PCI IDE bus master DMA is defined in the *ATA/ATAPI-4* or later standard.

A DVD drive and controller must support byte-aligned, multisegment, bus master DMA transfers. DMA must be enabled by default.

If attached by way of an ATA interface, ATAPI DVD drives and ATA system-board implementations must support DMA as specified in the *ATA/ATAPI-4* standard or SFF 8090.

**Note:** This requirement does not apply to legacy floppy disk controllers (FDCs) and will not become a requirement for legacy FDCs.

### [18.2] Removable media devices support media status notification

The following list shows the required specifications for implementing media status notification, depending on device type.

Device type	Media status notification implementation
CD and DVD devices	<del>Required</del> Comply with <i>ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)</i> standard for Media Status Event Notification.
ATAPI floppy/optical direct access drives	<del>Required</del> Comply with either MMC-2 standard or SFF 8070i Version 1.1.
IEEE 1394 storage devices	<del>Required</del> Comply with <i>NCITS Reduced Block Commands (RBC; T10/97-260r0)</i> standard.
ATA and non-ATAPI storage devices	<del>Required</del> Comply with <i>Media Status Notification Support, Version 1.03</i> .
Other ATA/ATAPI devices, including tape drives	<del>Recommended</del> If implemented, comply with <i>Media Status Notification Support Specification, Version 1.03</i> , or SFF 8070i.
Other types of SCSI	<del>Recommended</del> If implemented, support based on <i>NCITS</i>

removable devices *Reduced Block Commands* standard is recommended.

**[18.5] If implemented, Device Bay storage device complies with Device Bay 1.0 and other specifications**

All Device Bay controllers and devices included with a PC 2001 system or provided as retail devices must meet the requirements defined in *Device Bay Interface Specification, Version 1.0*. Any storage device designed as a Device Bay peripheral must also interface with USB, IEEE 1394, or both. If it interfaces with USB, the device must support the *Universal Serial Bus Device Class Definition for Mass Storage Devices, Version 1.09* or later.

**[18.6] ATA devices support Ultra DMA**

All ATA primary storage devices must support Ultra DMA at transfer rates of 33 MB per second or higher as defined in the ATA/ATAPI-4 standard, and as described in requirement [10.7], “Controller supports Ultra DMA.”

A peripheral that does not support the Ultra DMA transfer protocol must, at a minimum, implement the termination scheme required by this protocol in order to be tolerant of Ultra DMA.

**~~[18.10]—[DELETE] Host controller for secondary storage uses IEEE 1394~~**  
Recommendations are not included in PC 2001

**Note to Reviewers:** Section 18.10 has been removed for OEM industry discussion. It is intended that IEEE-1394 will propagate as the external storage connection for high-speed devices in the future. It is recognized that OEMs currently have selection of two or more interfaces for secondary or external storage, so there can be no firm requirement in this area.

## Floppy Disk Components

This section describes the specific requirements for any floppy disk capabilities provided with a PC 2001 system. The device must also meet the general requirements defined in “Storage Controller and Peripherals Basic Features” and “PC 2001 Design for Storage Components” in this chapter.

Although most systems include some form of floppy disk drive, some PC systems might not need one.

**Note to Reviewers:** A recommendation for floppy-less systems having the capability for recording optical media (either CD or DVD recordable) is being considered.

**[18.11] If implemented, floppy disk capabilities do not use legacy FDC**  
**Reviewers: please comment on this proposed PC 2001 guideline**

To support migration away from legacy devices, ~~it is recommended that~~ support for floppy disk drives must be provided by using a solution other than a legacy FDC. Solutions could include an MMC-2-compliant ATAPI floppy drive, USB, PC Card, SCSI, or ATA expansion card.

~~**[18.12] [DELETED] If implemented, legacy FDC complies with Legacy Plug and Play Guidelines**~~

~~**[18.13] [DELETED] System supports dynamic configuration of legacy FDC**~~

## Hard Disk Drives

This section summarizes specific requirements for hard disk drives. The device must also meet the general requirements defined in “Storage Controller and Peripherals Basic Features” and “PC 2001 Design for Storage Components” in this chapter.

**Note:** BIOS support is required for LBA for all read and write operations to ATA disk drives that have capacities greater than 528 MB. For more information, see requirement [10.5], “System BIOS and devices support LBA.”

**[18.14] [REDUNDANT] Operating system recognizes the boot drive in a multiple-drive system**

**Note to Reviewers:** This item is defined in the basic system BIOS requirement in item 3.5

**[18.15] ~~If implemented, hard drive that is~~ SMART-compliant hard drive meets data-handling requirements~~uses SMART IOCTL API~~**

If implemented, the drive must meet the requirements for data handling as defined in the SMART IOCTL API Specification, Version 1.1. The Self-Monitoring, Analysis, and Reporting Technology system (SMART) is an industry term used to describe technology that monitors and predicts device performance. ~~If implemented, it must meet the requirements for data handling as defined in the SMART IOCTL API Specification, Version 1.1 or later, published by Compaq Computer Corporation and Microsoft Corporation, describes the API used by an application to issue SMART commands to a hard drive under the Microsoft Windows family of operating systems. If SMART compliance is implemented, the driver must support the SMART IOCTLs.~~

## CD Devices

This section summarizes the requirements for CD peripherals. The device must also meet the general requirements defined in “Storage Controllers and Peripherals Basic Features” and “PC 2001 Design for Storage Components” in this chapter, including requirement [18.1], “Storage controller and devices support bus master capabilities.”

### [18.16] CD device provides 8x minimum transfer rate or better performance

This requirement sets the minimum speed needed for production level CD reading on Windows platforms. This requirement applies to the minimum read speed (8x) on any production level CD media, such as application or game software, at any location on the disc. This minimum speed requirement does not apply to end user recorded CD data discs, or discs being read in error-correcting, defect management mode. OEMs should continue to ship CD drives that produce an acceptable user experience and conform to the specifications cited in section 18.18.

### [18.17] CD drive is CD-enhanced compatible

The CD drive must be able to mount multisession CD-ROM discs, even if track 1 is Red Book audio. ~~Microsoft recommends use of the Sony ReadTOC method for SCSI-2 multisession support as defined in the MMC-2 standard.~~

CD-Enhanced support must be Blue Book compliant, as defined in *Enhanced Music CD Specification, Version 1.0*.

### [18.18] CD drive supports specified logical and physical CD formats

At a minimum, the CD drive must be compatible with the following formats to ensure cross-media compatibility, based on compliance with the *Optical Storage Technology Association (OSTA) MultiRead Specification for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Version 1.11*:

- ?? Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), Orange Book parts II and III (packet writing if recordable), White Book, Blue Book, and UDF versions 1.5 and 2.0.
- ?? Physical formats: ROM (stamped), and Orange Book part II (CD-R) and part III (CD-RW).

**Note:** Any ATAPI CD drive designed to play back CD-I content must return a minimum of two track entries for the READ\_TOC (0x43) command. These two track entries must be a track 01 entry and a track 0xAA entry for the lead-out address. Drives that do not comply with this minimum requirement cannot play back CD-I movies.

**[18.19] ATA/ATAPI CD drive complies with MMC-2**

CD drives attached to the system using the ATA interface must support the hardware and protocols documented in *ATA Packet Interface for CD-ROMs*, SFF 8020i, Version 2.6 or later.

**Note:** Support for the READ CD-DA command as defined in the MMC-2 standard is recommended. [Microsoft recommends use of the Sony ReadTOC method for SCSI-2 multisession support, as defined in the MMC-2 standard.](#)

**[18.20] CD drive supports multisession and compatibility forms of the READ\_TOC command**

Both multisession forms (01b and 10b) and the compatibility form (00b) of the READ\_TOC command must be implemented. This ensures complete support for CD-ROM multisession capabilities.

For information about ATAPI peripheral support for CD-I content, see requirement [18.18], “CD drive supports specified logical and physical CD formats.”

**[18.21] ATA/ATAPI CD changer complies with the MMC-2 standard**

If an ATAPI-compatible CD changer with a capacity for seven or fewer discs is present, the changer must comply with the MMC-2 standard.

**[18.22] CD device supports digital audio detection**

CD drives must support the bit “CD Capabilities and Mechanical Status Page” (2Ah), as defined in the MMC-2 standard. The bit “CD-DA Commands Supported” must be set if the drive can provide digital audio streams. This bit must be unset if the drive is not capable of digital audio.

The bit “CD-DA Stream is Accurate” of “CD Capabilities and Mechanical Status Page” can be set only if either the READ\_CD command or READ\_RAW command provides sector-accurate reads, as defined in MMC-2. Data alignment accuracy should be equivalent to that of data reads. Because of the lack of ECC bytes used for data tracks, the data itself may contain inaccuracies due to physical defects of the media. This bit must be unset if the conditions are not met.

**[18.23] CD and DVD devices use push-to-close design**

Except for mobile implementations, the device must be designed so the user has three options for closing the device when inserting a disc:

- ?? Physically pushing on the bay
- ?? Physically pushing the close button on the bay housing
- ?? Selecting a software-supported option to close the device

## Rewriteable Optical ATAPI Devices

This section summarizes specific requirements for rewriteable optical storage devices. The device must also meet the general requirements defined in “Storage Controller and Peripherals Basic Features” and “PC 2001 Design for Storage Components” in this chapter.

### [18.24] Block rewritable optical ATAPI device complies with SFF 8070i v1.1 or later

SFF 8070i defines the requirements for block rewriteable ATAPI devices, including specifications for logical unit number (LUN) implementation, media status notification, and device write protection. This [document](#) also includes required support for the Read Format Capacities command.

Implementation of multiple functions in a single drive must be done with a single LUN. Multiple LUN drives which present two separate devices to the consumer in the UI do not meet this requirement.

## DVD Devices

This section summarizes specific requirements for DVD devices. The device also must meet the general requirements defined in “Storage Controller and Peripherals Basic Features” and “PC 2001 Design for Storage Components” in this chapter.

For information about the requirements for DVD-Video and MPEG-2 playback performance, see Chapter [X], “Video and Broadcast Components.” For more information about DVD support under Windows 98 and Windows 2000 operating systems, see the articles at <http://www.microsoft.com/hwdev/devdes/dvdwp.htm>.

### [NEW] System has at least one DVD-ROM drive, at a minimum

All PC 2001 systems must have a DVD drive. At a minimum, the system will include a DVD-ROM drive that supports both CD-ROM and DVD-ROM capabilities. In support of removable rewritable media requirements it is suggested that this drive also offer support for CD or DVD re-writable functions also.

### [NEW] DVD drive reads all DVD formats

**Note to Reviewers: The following is being considered as a requirement for PC2001. We would appreciate your feedback.**

In PC 2001, all DVD drives must be able to read all DVD formats, including:

DVD-ROM	DVD-RW	CD-R
DVD-R	DVD+RW	CD-RW
DVD-RAM	CD-ROM	All CD book formats

**[18.25] DVD device provides 2x minimum transfer rate or better performance anywhere on the disc**

The minimum sustained DVD device media transfer rate must be at least 2 MB per second for read operations from the DVD disc.

This requirement sets the minimum speed needed for DVD-Video playback during MPEG2 decoding on Windows platforms. This requirement applies to the minimum read speed (2 MB/s) on any production level DVD-Video media, at any location on the disc. This minimum rate requirement does not apply to end user recorded DVD data discs, or discs being read in error-correcting, defect management mode. OEMs should continue to ship DVD drives that produce an acceptable user experience and conform to the specifications cited in section 18.27. Recommended: A 4X DVD-ROM at 4 MB per second sustained from the DVD disc.

**[18.26] [REDUNDANT] DVD drive and controller support bus master DMA transfers**

**Note to Reviewers: See item 18.1**

**[18.27] DVD drive meets minimum compatibility requirements**

DVD drives must support all the functionality of CD drives as outlined in “CD Devices” earlier in this chapter. ~~Specifically, the DVD device must be compatible with the following formats to ensure that the DVD device can read earlier media:~~

~~? Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), White Book, Orange Book parts II and III (packet writing), Blue Book, UDF versions 1.5 and 2.0, and DVD video if applicable.~~

~~? Physical formats: ROM (stamped), Orange Book part II (CD-R) and part III (CD-RW), and ECMA-267 and ECMA-268 (DVD-ROM).~~

~~Recommended: Support for ECMA-274 (PC+RW) and ECMA-272, 273 (DVD-RAM 1.0 and DVD-R).~~

~~Conforming to OSTA MultiRead Specification, Version 1.11 indicates compliance with all of these compatibility requirements.~~

**[18.28] DVD ~~device-drive~~ complies with the MMC-2 standard**

A DVD device must comply with the MMC-2 standard, which defines the implementation requirements that the Windows 98 or Windows 2000 operating systems support. The drive must support the following commands:

Beh	Read CD	08h	Device reset
B9h	Read CD MSF	A0h	Packet
4Bh	Pause/resume	A1h	Identify packet device



E5h	Check power mode	Efh	Set features
90h	Execute device diagnostic	E6h	Sleep
E1h	Idle Immediately	E0h	Standby immediate
00h	NOP		

DVD devices must also support the following:

- ?? Timeout model as designed and documented in MMC-2.
- ?? Get Event Status command (Media Event Status class) and all related commands, including Persistent Prevent/Allow, as defined in MMC-2.
- ?? Get Configuration command for Morphing class devices (Class 2), as defined in MMC-2. Windows 98 uses the Get Configuration command to determine whether media event status is supported correctly.

#### [18.30] DVD ~~device~~drive supports defect management

DVD drives must support defect management that is transparent to the operating system, according to industry standards. Defect management for DVD-RAM media is defined in *DVD Specifications for Rewritable Disc, Part 1: Physical Specifications*, published by Toshiba Corporation. Defect management for DVD+RW is defined in ECMA-274.

#### [18.31] DVD ~~device~~drive supports copyright protection

**Note to reviewers. This does not imply that you will have to license a 3<sup>rd</sup> party implementation..**

The drive must support a licensed implementation of the CSS copyright-protection scheme and support CSS-protected discs to ensure proper protection for prerecorded video content, as defined in the DVD specification.

Software is provided as part of the Windows 98 and Windows 2000 operating system support for DVD in order to facilitate the authentication process required by this scheme. This support allows a DVD drive to authenticate and transfer keys with a CSS content decrypter. Windows 98 and Windows 2000 operating system software ~~will~~acts as the agent to allow either hardware or software decrypters to be authenticated.

## PC 2001 Design for Storage Components

This section summarizes requirements related to Plug and Play and other resource-related design issues for storage devices.

~~[18.35] [DELETED] Physical security is provided for storage devices~~

**Note to Reviewers: Recommendations are not included in PC 2001**

**[18.37] Device and controller comply with Storage Device Class Power Management Reference Specification**

The *Storage Device Class Power Management Reference Specification*, Version **1.0** or later, provides definitions of the OnNow device power states (D0–D3) for these devices. The specification also covers device functionality expected in each power state and possible wake-up event definitions for the class. Support is required for power states D0, D1, and D3 for hard disks, CD and DVD drives, and other mass storage devices. Support for the D1 state is not required for floppy disk devices.

*Mobile PC Note*

~~For mobile hard drives, it is recommended that a Read operation typically be completed within 5 seconds of applying power or leaving the D1 state and transitioning to D3. For desktop systems, the recommendation is 10 seconds.~~

~~The drive spin-up time recommendation is not expected to become a requirement in future versions of this guide.~~

~~If implemented, the~~ The ability to cause a wake-up event must be as defined in the *Storage Device Class Power Management Reference Specification*, Version **1.0** or later, ~~is an optional feature.~~

~~[18.38] [DELETE] Device supports wake-up events~~

**Note to Reviewers: Recommendations are not include in PC 2001**

## Device Drivers and Installation for Storage

This section summarizes the basic requirements for device drivers and installation procedures for storage devices.

**[18.39] [REDUNDANT] Device drivers and installation meet PC 2001 requirements**

**Note to Reviewers: This basic PC 2001 requirement is no longer repeated in every chapter.**

**[18.40] Device driver runs in protected mode following installation**

The device driver must be running in 32-bit protected mode, not compatibility mode, immediately following installation.

**Note:** Although it is preferred that a system reboot not be required as part of device installation, it is recognized that installation of boot devices presents a special situation. It is acceptable that installation of a boot device includes restarting the system.

**[18.41] Applications provided with the device meet Win32 requirements**

Any Windows-based applications provided with the device must meet requirements for software compatibility, as defined in the Microsoft Platform SDK. However, any software applications included with the device can be installed using an alternate Windows-based installation method, as defined in the Microsoft Platform SDK.

**[18.42] Device driver for partitioned media supports all Windows 98 and Windows 2000 partition types**

Device drivers that support partitioned media must support all Windows 98 and Windows 2000 partition types, which include but are not limited to FAT16, FAT32, and NTFS, plus UDF 1.5 and 2.0 for CD and DVD.

**[18.43] Device driver for block-mode device supports extended BPBs**

Storage subsystems that include an MS-DOS-based block-mode device driver, for example, Aspidisk.sys, must support Extended BIOS Parameter Blocks (BPBs) in the Build BPB device driver function call, and must support category=48 in the generic IOCTL device driver interface calls, as specified in the latest update to the Windows 2000 DDK.

## SCSI Storage

This section presents guidelines for SCSI storage. The use of SCSI in a PC 2001 system is optional.

**[11.5] [REDUNDANT] Connector complies with bus standards and bus type is clearly indicated on connector****[11.6] Differential devices support DIFFSENS as defined in SPI standard**

Without DIFFSENS, the differential bus drivers, a single-ended device, or both could be damaged if a single-ended device is connected to a differential bus. The standard for DIFFSENS is defined in Section 5.4.2 of the SPI standard.

**Note to Reviewers: This reference will be corrected in coming draft versions.**

**[11.10] Controller and peripherals implement SCSI bus data protection signal**

The SCSI host adapter and all SCSI peripherals must implement the SCSI bus data protection signal defined in the SPI standard, and data protection must be enabled by default. This signal was formerly referred to as the parity signal.

**[11.12] External devices use automatic termination or an accessible termination switch**

An external SCSI peripheral device must provide automatic termination. At a minimum, a mechanical means must be provided for setting termination and the switch must be accessible to the user without opening the device chassis.

**[11.22] Devices supports the STOP/START UNIT command as defined in the SPI-3 or later standard**

SCSI peripherals must be able to fully recover from a software-initiated spin down without rebooting the system or cycling power. To properly support power management on SCSI drives and to ensure that the operating system responds to appropriate driver calls, the STOP/START UNIT command must be implemented as defined in the SPI (SCSI-3) standard.

**[11.23] STOP/START UNIT command is used to decrease power consumption**

Wherever appropriate, such as for storage disks, the STOP UNIT command must be used to decrease the power consumption of the base platform. Removing power should not be used as the method for spinning down storage disks.

## ATAPI Storage

This section defines the requirements for all ATAPI storage devices.

**[10.9] Peripherals comply with ATA/ATAPI-4**

The ATA/ATAPI-4 standard defines hardware and software design guidelines for ATAPI devices.

**[10.12] ATAPI devices support DEVICE RESET command**

ATAPI devices must respond to the DEVICE RESET command regardless of their internal state, as defined in the ATA/ATAPI-4 standard. The controller can be reset ~~by going into~~entering a power-on state (requests cleared, signature present), but any non-default mode values must be left in their current state with the DRV bit unchanged.

Devices that do not implement the PACKET command feature set, such as hard disk drives, must not implement the DEVICE RESET command.

**[10.18] ATA device supports ATA STANDBY command**

ATA drives must implement the ATA STANDBY command, as defined in the ATA/ATAPI-4 standard.

~~For mobile ATA drives, it is recommended that a Read operation typically be completed within 5 seconds of applying power or leaving ATA STANDBY mode.~~

~~and transitioning to ATA ACTIVE. For desktop systems, the recommendation is 10 seconds.~~

Information on system power states and transitions can be found in *Storage Device Class Power Management Reference Specification, Version 1.0* or later.

~~The drive spin-up time recommendation is not expected to become a requirement in future versions of this guide.~~

## Checklist for Storage

- [18.1] Storage components and optical devices support bus master capabilities
- [18.2] Removable media devices support media status notification
- [18.5] If implemented, Device Bay storage device complies with Device Bay 1.0 and other specifications
- [18.6] ATA devices support Ultra DMA
- [18.11] If implemented, floppy disk capabilities do not use legacy FDC
- [18.14] [REDUNDANT] Operating system recognizes the boot drive in a multiple-drive system
- [18.15] If implemented, SMART-compliant hard drive meets data-handling requirements
- [18.16] CD device provides 8x minimum transfer rate or better performance
- [18.17] CD drive is CD-enhanced compatible
- [18.18] CD drive supports specified logical and physical CD formats
- [18.19] ATA/ATAPI CD drive complies with MMC-2
- [18.20] CD drive supports multisession and compatibility forms of the READ\_TOC command
- [18.21] ATA/ATAPI CD changer complies with the MMC-2 standard
- [18.22] CD device supports digital audio detection
- [18.23] CD and DVD devices use push-to-close design
- [18.24] Block rewritable optical ATAPI device complies with SFF 8070i v1.1 or later
- [NEW] System has at least one DVD-ROM drive, at a minimum
- [NEW] DVD drive reads all DVD formats
- [18.25] DVD device provides 2x minimum transfer rate or better performance anywhere on the disc
- [18.26] [REDUNDANT] DVD drive and controller support bus master DMA transfers
- [18.27] DVD drive meets minimum compatibility requirements
- [18.28] DVD drive complies with the MMC-2 standard
- [18.30] DVD drive supports defect management
- [18.31] DVD drive supports copyright protection
- [18.37] Device and controller comply with Storage Device Class Power Management Reference Specification
- [18.39] [REDUNDANT] Device drivers and installation meet PC 2001 requirements
- [18.40] Device driver runs in protected mode following installation
- [18.41] Applications provided with the device meet Win32 requirements
- [18.42] Device driver for partitioned media supports all Windows 98 and Windows 2000 partition types
- [18.43] Device driver for block-mode device supports extended BPBs
- [11.5] [REDUNDANT] Connector complies with bus standards and bus type is clearly indicated on connector
- [11.6] Differential devices support DIFFSENS as defined in SPI standard
- [11.10] Controller and peripherals implement SCSI bus data protection signal
- [11.12] External devices use automatic termination or an accessible termination switch
- [11.22] Devices supports the STOP/START UNIT command as defined in the SPI-3 or later standard
- [11.23] STOP/START UNIT command is used to decrease power consumption
- [10.9] Peripherals comply with ATA/ATAPI-4

- [10.12] *ATAPI devices support DEVICE RESET command*
- [10.18] *ATA device supports ATA STANDBY command*